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REVIEW/DERLEME

The Effect of Pain Neuroscience Education on Pain and Disability Following Arthroscopic Rotator Cuff Repair: A Narrative Review

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ABSTRACT

Post-arthroscopic rotator cuff repair pain is common and can be influenced by psychological factors such as pain catastrophizing, anxiety, depression, and kinesiophobia. Pain Neuroscience Education is a treatment strategy that helps patients understand the factors influencing pain beliefs and behaviors, aiming to change maladaptive thoughts, such as pain catastrophizing, and improve their understanding of chronic pain. The purpose of this review was to examine studies that have applied Pain Neuroscience Education after arthroscopic rotator cuff repair and to determine and summarize the effectiveness of this training in improving pain and disability. A literature search was conducted in PubMed, PEDro, Scopus, and Google Scholar databases to identify clinical studies on arthroscopic rotator cuff repair. Eligible clinical studies investigating the effects of Pain Neuroscience Education on pain and disability after arthroscopic rotator cuff repair were identified from the above databases and a narrative review was performed. According to the findings of the studies, Pain Neuroscience Education has been shown to provide similar improvements in pain and disability compared to biomedical education or standard rehabilitation. However, one study reported a significant improvement of Pain Neuroscience Education pain in movement compared to biomedical education. It appears that the results of Pain Neuroscience Education regarding pain do not show significant advantages over biomedical education or standard rehabilitation, the outcomes related to disability are more promising. Confirming the results requires further studies with larger sample sizes. Additionally, future research should establish the optimal dosage, content, and duration of Pain Neuroscience Education.
Keywords: Arthroscopic rotator cuff repair, neuroscience education, pain, shoulder surgery.

Artroskopik Rotator Cuff Tamirinden Sonra Ağrı Nörobilim Eğitimi'nin Ağrı ve Dizabilite Üzerine Etkisi: Geleneksel Derleme

ÖZET

Artroskopik rotator cuff tamiri sonrası ağrı, hastalar için yaygın bir endişe kaynağıdır. Ağrının yanı sıra, ağrıyı felaketleştirme, anksiyete, depresyon ve kinezyofobi gibi faktörler hastalarda duygusal ve bilişsel değişikliklere sebep olabilir. Ağrı Nörobilim Eğitimi, hastalara ağrı deneyimini etkileyen inanç ve davranışlarla ilişkili temel faktörleri öğretmeye odaklanan bir tedavi stratejisidir. Hastayı kronik ağrıyı anlamaya teşvik eder ve ağrıyı felaketleştirme gibi uyumsuz düşünce ve inançları değiştirmeyi amaçlar. Bu derlemenin amacı, artroskopik rotator cuff tamirinden sonra hastalara Ağrı Nörobilim Eğitimi uygulayan çalışmaları incelemek ve bu eğitimin hastaların ağrı ve dizabilitesini iyileştirmedeki etkinliğini belirlemek ve özetlemektir. Artroskopik rotator cuff tamiri ile ilgili klinik çalışmaları belirlemek için PubMed, PEDro, Scopus ve Google Scholar veri tabanlarında bir literatür taraması yapıldı. Yukarıdaki veritabanlarından Ağrı Nörobilim Eğitimi'nin artroskopik rotator cuff tamiri sonrası ağrı ve dizabilite üzerindeki etkilerini araştıran uygun klinik çalışmalar belirlenmiştir ve bir derleme yapılmıştır. Çalışmaların sonuçlarına göre, PNE'nin ağrı ve sakatlık açısından biyomedikal eğitim veya standart rehabilitasyon programları ile benzer iyileşme sağladığı görülmektedir. Bir çalışmada aktivite sırasında ağrıyı iyileştirmede biyomedikal eğitime göre anlamlı fark bulunmuştur. Ağrı Nörobilim Eğitimi'nin ağrı ile ilgili sonuçlarının biyomedikal eğitim veya standart rehabilitasyon programlarına göre önemli avantajlar göstermediği, dizabilite ile ilgili sonuçların daha ümit verici olduğu görülmektedir. Sonuçları doğrulamak için daha büyük örneklem boyutlarına sahip daha fazla çalışmaya ihtiyaç vardır. Ayrıca gelecekteki araştırmalar, Ağrı Nörobilim Eğitimi'nin optimal dozajını, içeriğini ve süresini belirlemelidir.
Anahtar Kelimeler: Artroskopik rotator manşet tamiri, nörobilim eğitimi, ağrı, omuz cerrahisi.

1. Introduction

Shoulder pain is one of the most common musculoskeletal problems. Rotator cuff (RC) pathology, in particular, is a frequently encountered clinical condition with a global prevalence of 20.7% (1). RC disease related to shoulder pain and disability and is one of the most common reasons for referral to physiotherapy clinics (2). Most shoulder pains associated with RC pathology respond well to conservative treatment approaches (3). In cases of conservative treatment failure, RC repair surgeries may be performed (4).

Arthroscopic surgical repair is a procedure that offers several advantages compared to open approaches (5). Although various rehabilitation protocols are suggested after arthroscopic rotator cuff repair (ARCR), the postoperative rehabilitation phase

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progresses according to the tendon healing process. Early or delayed rehabilitation protocols are applied after surgery. Recent studies have discussed the effectiveness of early and delayed rehabilitation approaches following surgery (6).

Post-ARCR pain is a commonly encountered and primary concern in patients (7). Pain is a subjective physical and emotional experience that functions as a defense mechanism; therefore, the most common result of this condition is the immobilization of the affected shoulder. Consequently, the physiotherapist must find a compromise between gradually improving shoulder function and controlling pain (8). Emotional-cognitive changes have been reported in patients following surgery and postoperative pain catastrophizing, anxiety, depression levels, and the presence of kinesiophobia may be associated with these emotional-cognitive changes (9). Therefore, it is important for interventions after surgery to address psychosocial factors as well.

Pain neuroscience education (PNE) is a treatment strategy focused on teaching patients the key factors associated with beliefs and behaviors that contribute to the experience of pain. It consists of educational sessions that explain the neurobiology and neurophysiology of chronic pain, focusing on the role of the Central Nervous System (CNS) in chronic pain and reducing emphasis on anatomical topics. Education encourages the patient to understand chronic pain and aims to change maladaptive thoughts and beliefs, such as catastrophizing pain (10,11). There is evidence supporting the effects of PNE on improving pain and function in musculoskeletal pain (10). However, the number of studies investigating the effects of PNE in post-surgical patients is relatively limited. The existing literature focuses on spinal surgery, total knee arthroplasty, cancer surgery, and shoulder surgery, and the results are conflicting (12-18). Some studies report similar outcomes with PNE as compared to biomedical education or rehabilitation practices (13-16), while others suggest that PNE may be more beneficial than biomedical education (17) or conventional treatments (18).

Although there is no consensus in the literature regarding the efficacy of PNE in patients following ARCR and the number of studies investigating the effectiveness of PNE following ARCR remains insufficient. Furthermore, there is a lack of standardization in clinical trials regarding the duration and content of the training. Therefore, the purpose of this review is to examine studies that have applied PNE after ARCR and to determine and summarize the effectiveness of this training in improving patients' pain and disability.

1.1. Arthroscopic Rotator Cuff Repair (ARCR)

Rotator cuff (RC) tears are treated using either conservative or surgical methods, depending on factors such as the size and shape of the tear, the patient's age, activity level, and expectations. In individuals with acute injuries who are younger and have a higher activity level, surgical treatment may be preferred (19). However, when conservative treatments fail, surgical intervention is also applied (4).

RC repair is generally an elective surgery that requires careful evaluation and discussion regarding treatment expectations, risks, and benefits (4). The primary goal of RC repair is to alleviate pain and improve function by increasing joint range of motion and muscle strength (6). In most patients, RC tear repairs result in good or excellent outcomes, with significant improvements in self-reported measures. However, factors such as age, gender, smoking, tear size, and tendon quality can impact the results of RC repair (4). Various surgical approaches, including open, mini-open, and arthroscopic techniques, are used in RC repair (6). The choice of surgical method depends on the size and mechanical properties of the tear, the patient's expectations, the surgeon's experience, and scientific evidence regarding the techniques used (20).

In the treatment of massive tears, open repair is generally preferred, whereas ARCR is more commonly utilized for small to medium-sized tears compared to the open method. Additionally, arthroscopic techniques are especially emphasized when shoulder range of motion and muscle strength are relatively preserved, but the severity of pain necessitates surgical intervention (19). ARCR is a minimally invasive method used to treat tears in the shoulder joint. This procedure involves repairing torn tendons using an arthroscope and specialized surgical tools through small incisions (6). Advantages of this technique include less tissue damage, reduced shoulder stiffness, immediate postoperative pain relief, and a better rehabilitation opportunity (20).

Over the past twenty years, ARCR has become the most popular surgical treatment for RC pathology. The increase in its application is attributed to the aging population, higher activity levels among patients, and significant advancements in arthroscopic techniques and fixation options available to surgeons (21). Notably, the double-row repair technique has been highlighted for preserving the acromiohumeral distance, which may reduce the risk of progression to tear arthropathy. While this technique has shown better biomechanical results, it has not been proven to be superior in clinical outcomes or repair integrity compared to the single-row repair technique. Although the superiority of different arthroscopic techniques is not clearly established, a good understanding of the tear pattern is crucial for successful ARCR (22).

The primary goal after ARCR is to prevent further injury to the tissue and restore normal joint range of motion and function. Therefore, optimal tendon healing should be supported by gradual loading through appropriate movements and exercises (22). The implementation of a proper rehabilitation program with appropriate movements after surgery, coordinated effective communication and care between the physiotherapist and surgeon, and optimal patient education are essential for positive surgical outcomes (6).

1.1.1. Association of ARCR with Pain and Other Psychosocial Conditions

In individuals with shoulder pain associated with RC pathology, identifying a specific structure or pathology as the primary cause of pain is challenging (23). Research indicates that there is no direct correlation between the size of the lesion detected on imaging and the reported pain. The clinical course in these patients is influenced by cognition, emotions, behaviors, and sociocultural factors. Moreover, it is well-established that patients' beliefs and perceptions regarding the causes of their pain can significantly affect clinical outcomes. Studies highlight the potential role of psychosocial factors and the phenomenon of central sensitization in patients' pain complaints (23,24).

Due to its minimally invasive nature, ARCR has fewer post-operative pain complications compared to open surgical repair (20). However, patients may still experience post-operative pain that requires treatment (21,25). Pain is an expected response in individuals following surgery during the post-operative period, and it can increase morbidity, lead to chronic pain conditions and reduce patients' quality of life. (26). Various analgesic methods are employed in post-operative pain management, including non-opioid analgesia, cryotherapy, nerve blocks, and subacromial injections. However, these methods have certain advantages and disadvantages in pain reduction, and post-operative pain remains a significant issue for both surgeons and patients. There is a need for cost-effective, patient-satisfaction-focused, and minimally complicated pain control methods (21).

Pre-operative psychosocial factors in patients with shoulder pain have been reported to be associated with surgical success and the presence of persistent post-operative pain (26,27). These factors also negatively impact the levels of disability and pain experienced prior to surgery (27). Additionally, it has been reported that emotional-cognitive changes can be observed in patients after surgery, and that post-operative pain catastrophizing, anxiety, depression levels, and the presence of kinesiophobia may be related to these emotional-cognitive changes (9). Fear-avoidance behaviors have been linked to persistent symptoms and decreased activity following rehabilitation (28). The importance of understanding and addressing patients' individual concerns and treatment goals has been emphasized (29).

1.2. Pain Neuroscience Education

Patient education is a part of the treatment for patients with shoulder pain and patients are provided with information about exercise, activity modification, working within pain limits and rules for daily living activities, biomechanics and instructions to reduce the load on the shoulder (30). Since these interventions usually define pain from a biomedical perspective (e.g., descriptions of structures that may cause pain and analgesic recommendations), they may be lacking in explaining other reasons why pain may persist beyond the healing process (31). However, it has been emphasized that biomedical-based education that provides only tissue health-based explanations for pain for patients may increase rather than reduce the pain experience by causing fear, fear avoidance and pain catastrophizing (32-35). Therefore, instead of a traditional biomedical model in patients, an approach is needed that focuses on neurophysiology, the representation and meaning of pain, and aims to desensitize the nervous system and focuses on biopsychosocial factors in pain management (36).

Pain neuroscience education (PNE) is a biopsychosocial education method that aims to help individuals reconceptualize their pain in a less threatening way and has recently become increasingly popular. Alternative terms used to describe PNE in the literature include pain explanation, therapeutic neuroscience education, pain biology education, and pain neurophysiology education (37). PNE aims to centralize desensitization by focusing on the neurophysiology, neurobiology, representation of pain, and meaning of pain for patients with chronic nociplastic pain or those at risk for chronic pain with psychosocial factors, which distinguishes it from traditional pain education. The neurophysiology of pain addresses topics such as spinal inhibition and facilitation, the role of the brain in pain perception, peripheral and central sensitization, plasticity and the nervous system, psychosocial factors contributing to pain, and pain coping strategies (33). These educational sessions are typically delivered by a healthcare professional. The content is often derived from books in the literature, such as “Explain Pain or Why You Hurt?”. The training can be provided through individual verbal consultations, group education, information from books without face-to-face interaction, or tele-rehabilitation (via video conferences or phone calls). During presentations, images, drawings, examples, and metaphors may be used. Various homework assignments and question-answer activities can reinforce the learning process. The duration of these sessions typically spans 1-2 hours, though the length can vary depending on the needs of the participants and the scope of the material being covered (10).

One of the core principles of PNE is the reconceptualization of pain, encouraging patients to view their pain from a different perspective. This means that even though patients may continue to experience pain, they are encouraged to think about it differently and relate it to the sensitivity of the nervous system rather than the health of the tissues. Additionally, this reconceptualization process conveys the message that it is important to continue moving, exercising, remaining active, and engaging in daily life "despite the pain." It also supports the notion that seeking further treatment aimed at reducing pain sensitivity may be unnecessary (11).

1.2.1. Pain Neuroscience Education and Literature

In recent years, there has been an increase in both the quantity and quality of research on PNE and most of these studies show promising results for PNE (36). Research focusing on chronic pain conditions such as non-specific chronic low back pain, osteoarthritis, fibromyalgia, chronic neck pain, radiculopathy, total knee arthroplasty, and carpal tunnel syndrome has explored the effectiveness of PNE, with the majority reporting positive results regarding its effectiveness (38-40). Supporting evidence suggests that PNE improves pain intensity, pain knowledge, disability, pain catastrophizing, fear-avoidance behaviors, pain-related attitudes and behaviors, and physical movement in chronic musculoskeletal pain (10,12). Furthermore, many studies have investigated the use of PNE in combination with methods such as manual therapy, exercise, dry needling, and graded exposure. It has been suggested that combining education with passive and/or active movements could be a key factor in the success of PNE (39,41). When PNE is combined with exercise or manual therapy, it has been reported to be far more effective in reducing pain compared to education alone (41). Siddall et al. (2022) found in a systematic review that combining PNE with exercise resulted in improvements in pain, disability, kinesiophobia, and catastrophizing in the short term compared to exercise alone for the treatment of chronic musculoskeletal pain (12).

The effectiveness of PNE has also been explored in individuals with chronic shoulder pain, but the evidence is limited. One case study investigated the effectiveness of PNE combined with tactile discrimination and graded motor imagery in a patient with frozen shoulder, reporting improvements in pain, range of motion, and function after 6 weeks of education (42). Additionally, two feasibility studies have examined the effectiveness of PNE in individuals with RC related shoulder pain. The findings from these studies suggest that post-education, factors influencing

shoulder pain experience were better understood, participants were more willing to apply pain education principles to daily life, and they gained a new perspective on RC related shoulder pain with improvements in self-management and coping strategies (23,43).

1.2.2. Pain Neuroscience Education and Rotator Cuff Repair in Literature

A literature search was conducted on 24 November 2024 in PubMed, PEDro, Scopus, and Google Scholar databases to identify clinical studies on arthroscopic RC repair. The string pain education OR pain neurophysiology OR neuroscience education OR pain neuroscience education AND rotator cuff surgery OR shoulder surgery OR arthroscopic rotator cuff repair was used in the searches. Studies investigating the effects of PNE on individuals who have undergone ARCR were the focus.

Appropriate clinical studies investigating the effects of PNE after ARCR were identified from these databases, and a descriptive review was conducted. A literature search revealed four studies examining the effectiveness of PNE in shoulder surgery. According to the results, one study was a case series and three study were randomized controlled trials. The case series was excluded from the review due to the lack of clear information regarding the specifics of the shoulder surgery and because the study focused on the pre-operative effectiveness of the education (44). This review includes the results of the three randomized controlled trials identified.

Kim et al. (15) investigated the effectiveness of PNE in individuals aged 18-65 who underwent ARCR surgery. The study compared a 4-week rehabilitation program consisting of physical agents, manual therapy, and exercise (5 days per week) starting 4 weeks after surgery, with the same rehabilitation program supplemented by two PNE sessions (one face-to-face and one none face-to-face (video-recorded)), each lasting 30 minutes, delivered over 4 weeks. PNE covered topics such as pain types, pain neurophysiology, nociception, pain control mechanisms, peripheral and central sensitization, plasticity, treatment with PNE, as well as biomechanics and details and procedures related to arthroscopic RC repair. According to the results at baseline, 6-, 8-, and 10-weeks post-surgery, no differences were observed between the groups in terms of pain intensity and disability. However, PNE results showed a larger effect size (15).

Ponce-Fuentes et al. (16) compared PNE applied as an adjunct to rehabilitation, with biomedical education, in individuals aged 30-59 who underwent ARCR surgery. Both types of education were delivered during the first four weeks of rehabilitation, with four sessions of 30 minutes each. The PNE sessions covered topics such as pain, psychosocial factors in pain experience, the differences between acute and chronic pain, and peripheral and central sensitization. Biomedical education focused on the anatomy and pathomechanics of the shoulder. All participants followed a standard rehabilitation program for 8 weeks, progressing from immobilization to active movement and strengthening, with three sessions per week. Post-treatment results at the 4th and 8th weeks showed that both educational approaches similarly improved resting pain and disability. However, PNE was found to be more effective in improving pain in movement (16).

Karatri et al. (18) compared the effectiveness of conventional therapy (5 days/week for 6 weeks) and conventional therapy combined with PNE (1 day/week for 6 weeks, 15-60 minutes/session) in individuals aged 18-65 who underwent arthroscopic RC repair surgery. Conventional therapy included physical therapy modalities, manual therapy, and progressive strengthening programs. PNE addressed topics such as the neurophysiology of pain, the transition of pain from acute to chronic phases, and the nervous system's ability to modulate the pain experience. Pain and disability improvements at 6 weeks showed similar results between the PNE and the conventional therapy groups (18). The details of the studies are shown in Appendix 1.

1.2.2.1. Quality Assessment of the Studies

The methodological quality of the included studies was evaluated using the PEDro scale. This 11-item scale assesses various aspects of study methodology. The total score ranges from 0 to 10 (item 1 is not scored). Higher scores indicate better methodological quality. Previous research has shown the scale to be valid and reliable (45,46). Studies scoring six or above are considered high quality (47). All trials included in this review achieved scores of six or higher. The methodological quality of the included studies is presented in Table 1.

Table 1. Pedro scale scores of included studies

Studies	1	2	3	4	5	6	7	8	9	10	11	Total Score
Kim et al.[15] (2022)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Ponce-Fuentes et al.[16] (2023)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Karatri et al.[18] (2024)	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	6

Criterion in the pedro scale (Y: yes; N: no); 1: Specified eligibility criteria (thisitem is not used to calculate the scores); 2: Random allocation; 3: Concealed allocation; 4: Baseline comparability; 5: Blinding of subjects; 6: Blinding of therapists; 7: Blinding of assessors; 8: Adequate follow-up (> 85%); 9: Intention-to-treat analysis; 10: Between-group statistic comparisons; 11: Reporting of point measures and measures of variability.

2. Conclusion and Recommendations

As a result of the literature review, it has been observed the effects of PNE on pain and disability in individuals who have after ARCR have been investigated in randomized controlled trials with comparison groups including biomedical education and/or rehabilitation. Upon examining the existing studies, it appears that PNE regarding pain and disability similar improvements with biomedical education or standard rehabilitation programs.

PNE can be added as an alternative to the rehabilitation program to improve pain in movement, but it must be applied by physiotherapists experienced in this field, which may limit the application. A limitation of the studies reviewed is the lack of standardization regarding the duration and frequency of the interventions and recommendations the optimal dose of PNE.

Further studies with larger sample sizes are needed to confirm and recommend to the PNE for improving pain and disability following ARCR. Furthermore, the optimum dosage of PNE should be determined and standardization regarding the content and duration of education should be ensured.

3. Contribution to the Field

Pain is one of the major issues encountered in patients following ARCR. Although various medical and non-medical approaches are employed in treatment, these strategies often fail to adequately address underlying psychosocial factors. Identifying the optimal therapeutic strategy to reduce pain and disability in post-ARCR patients is essential for improving healthcare outcomes and alleviating the treatment burden. Our study aims to provide a holistic perspective on this approach by analyzing the findings of research investigating the effects of the increasingly applied PNE on pain and disability following ARCR.

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Conflict of Interest

There is no conflict of interest with any person and/or institution.

Authorship Contribution

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Appendix 1. Studies investigating the effects of PNE on pain and disability in individuals following ARCR

Author(s)	Study Design	Participants	Intervention Group	Comparator Group	Outcome	Session frequency	Per Session Duration	Results
Kim et al.[15] (2022)	RCT	Aged 18-65 (n= 34)	PNE + Rehabilitation PNE: Pain types, pain neurophysiology, nociception, pain control mechanisms, peripheral and central sensitization, plasticity, treatment with PNE, as well as biomechanics and details and procedures related to ARCR	Rehabilitation: Physical agents + Manual therapy + Exercise	-NPRS -K-DASH -K-SPADI	PNE: 2 sessions Rehabilitation: 5 sessions per week for 4 weeks	PNE: lasting 30 minutes Rehabilitation: 35 minutes physical agent, 30 minutes manual therapy, 50 minutes exercise	0-6, 0-8 and 0-10 weeks: NPRS, K-DASH, K-SPADI: PNE + Rehabilitation = Rehabilitation
Ponce-Fuentes et al.[16] (2023)	RCT	Aged 30-59 (n= 29)	PNE + Rehabilitation PNE: Pain, psychosocial factors in pain experience, the differences between acute and chronic pain, and peripheral and central sensitization	Biomedical Education + Rehabilitation Biomedical Education: Shoulder anatomy, biomechanics and pathomechanics Rehabilitation: Progressing from immobilization to active movement and strengthening	-VAS -QuickDASH	Educations: Once a week during the first 4 weeks Rehabilitation: 3 sesssions per week for 8 weeks	PNE: 30 minutes Biomedical Education: 30 minutes Rehabilitation: 60 minutes	0-4 and 0-8 weeks: VAS at rest, VAS in movement, QuickDASH: VAS at rest: PNE + Rehabilitation =Biomedical Education + Rehabilitation VAS in movement, QuickDASH: PNE + Rehabilitation > Biomedical Education + Rehabilitation
Kararti et al.[18] (2024)	RCT	Aged 18-65 (n= 36)	PNE + Conventinal Treatment PNE: Neurophysiology of pain, the transition of pain from acute to chronic phases, and the nervous system's ability to modulate the pain experience	Conventional Treatment: Physical therapy modalities, manual therapy, and progressive strengthening programs	-VAS -SPADI -DASH	PNE: Once a week for 6 weeks Conventional Treatment: 5 sesssions per week for 6 weeks	PNE: 15-60 minutes Conventional Treatment: 90 minutes	0-6 weeks VAS, SPADI, DASH: PNE + Conventional Treatment = Conventional Treatment

RCT: Randomized controlled trial; PNE; Pain neuroscience education; K-DASH: Korean version of the disabilities of the arm, shoulder and hand; K-SPADI: The Korean version of the shoulder pain and disability index; quichdash: Quick disabilities of the arm, shoulder and hand Questionnaire; VAS: Visual Analogue Scale